

Effect of the Structure of Anode Catalyst Layer on the Performance of DMFCs

J.-H. Kim, Y. M. Koo, H. Y. Ha*, I.-H. Oh*,
S.-A. Hong*, and H.-I. Lee

Seoul National University, Seoul 151-744, Korea
*Korea Institute of Science & Technology,
Seoul 136-791, Korea

Establishment of optimal preparation condition for anode in direct methanol fuel cell (DMFC) is very important. Among various factors structures of catalyst layers have tremendous effects on the performances of DMFC by changing mass transport and ionic conductance through the layers

Ionomer content in the catalyst layer and also in the catalyst inks are one of many factors changing catalyst layer structure. Increase of the recast ionomer content in the anode catalyst layers causes increase of proton conductivity, decrease of electron conductivity, and changes of carbon dioxide pathway(1,2). Another factor is the property of the solvent used in catalyst inks. According to Uchida *et al.*(3), solubility of Nafion® ionomer was controlled by dielectric constant of organic solvents, and PEMFC with electrodes prepared by using butyl acetate as a solvent for catalyst inks showed an improved performance.

In this study, we investigated on the effect of ionomer content by changing ionomer contents in the anode catalyst layers using different commercial catalysts and also investigated the effect of solvents used for preparation of catalyst ink. Special attention was paid to the change of proton or electron conductivity and catalyst layer structure brought about by changing the preparation parameter.

Catalysts used in anode were 40 wt% PtRu/C (E-Tek), 50 wt% PtRu/C (Tanaka), and PtRu black (Johnson-Matthey Co.). Recast ionomer was 5 wt% Nafion® solution (Dupont). The ratios of ionomer to catalyst weight were in the range from 1/24 to 1/2 in the anode catalyst layers. Solvents for catalyst inks were IPA ($\epsilon = 18.30$), NBA ($\epsilon = 5.01$), and so on.

DMFC performances with ionomer content did not show simple volcano curves but M-shaped curves. If only changes of conductivity were considered, volcano curves should be shown. However, it was likely that the changes of carbon dioxide pathway and/or particle size of the catalyst agglomerates resulted in these results.

In the case of the effects of solvents used for catalyst ink, the electrode with NBA forming PFSI colloid had better performance than those with IPA forming solution. It may be explained by the enlarged pore structures of the NBA-electrodes which enhances the removal of carbon dioxide.

References

1. A. S. Arico, A. K. Shukla, K. M. El-Khatib, P. Creti ,
and V. Antonucci, J. Appl. Electrochem., 29, 671
(1999).
2. S. C. Thomas, X. Ren, and S. Gottesfeld,
J. Electrochem. Soc., 146, 4354 (1999).
3. M. Uchida, Y. Aoyama, N. Eda, and A. Ohta,

J. Electrochem. Soc., 142, 463 (1995).

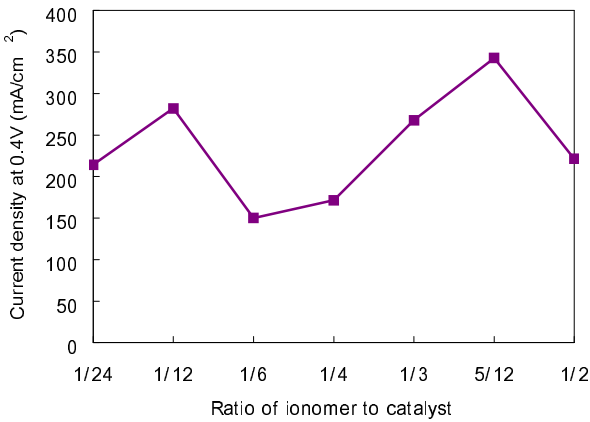


Fig. 1. Effects of ratio of ionomer to catalyst on current density at 0.4 V.

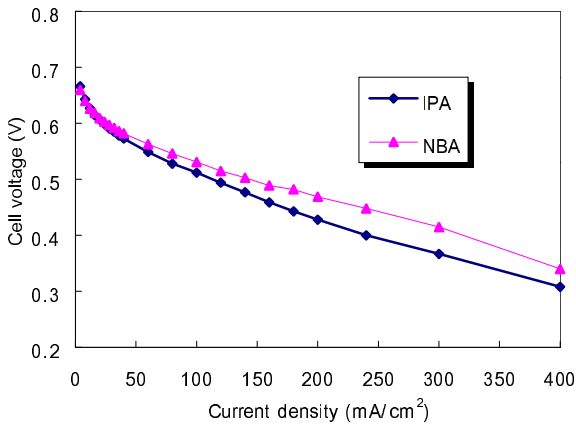


Fig. 2. Effects of solvent on the cell performance.